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ABSTRACT

The paper discusses the process and logistical experiences of developing science, technology and mathematics (SMT) curricula materials at the primary and secondary school levels in Uganda. The author developed the approach as part of the Female Education in Mathematics and Science in Africa (FEMSA) project. FEMSA is an Africa regional project that aims at improving girls' access, participation, and performance in SMT at the primary and secondary school levels in Africa. At the time of writing this paper, FEMSA was being implemented in 11 African countries, including Uganda. To date the most common approach to curriculum development is the centralized approach involving subject experts at the higher levels to develop curricula content at a national curriculum development center. This paper describes the efforts made to involve practicing school teachers in school-based curriculum development under the FEMSA-Uganda project. Based on these experiences, the author proposes improvements to the process, which are likely to have a greater impact on learners, particularly the girls, in terms of motivating them, increasing their interest, participation and hence improving their performance in SMT at the primary and secondary school levels in Africa. (Contains 12 references.) (Author/YDS)

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# SCHOOL-BASED CURRICULUM DEVELOPMENT: A PROPOSAL FOR IMPROVING GIRLS' PERFORMANCE IN SMT

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**Abstract**

The paper discusses the process and logistical experiences of developing science, technology and mathematics (SMT) curricula materials at the primary and secondary school levels in Uganda. The author developed the approach as part of the Female Education in Mathematics and Science in Africa (FEMSA) project. FEMSA is an Africa regional project that aims at improving girls' access, participation and performance in SMT at the primary and secondary school levels in Africa. At the time of writing this paper, FEMSA was being implemented in 11 African countries, including Uganda.

To date the most common approach to curriculum development is the centralized approach involving subject experts at the higher levels to develop curricula content at a national curriculum development center. This paper describes the efforts made to involve practicing schoolteachers in school-based curriculum development under the FEMSA-Uganda project. Based on these experiences, the author proposes improvements to the process, which are likely to have a greater impact on learners, particularly the girls, in terms of motivating them, increasing their interest, participation and hence improving their performance in SMT at the primary and secondary school levels in Africa.

## Introduction

Uganda was among the 4 countries that piloted the FEMSA project for two years (1996-97), the others being Cameroon, Ghana, and Tanzania. During this phase, each country carried out research that identified the problems that girls experience in the teaching/learning of SMT at the primary and secondary school levels. The FEMSA-Uganda research identified many problems, which included the economic and social-cultural barriers, the negative attitudes of parents, teachers and the general society towards girls' education, the poor curricula and the gender-biased curricula materials. The problems were similar to those identified in other countries under the same project, and the overall FEMSA project findings have been widely disseminated in Africa and beyond (Ebout Mfou et al, 1998; O'Connor 1998, Mulemwa 1999 & 2000) and discussed at different forums such as the GASAT –Africa regional meeting of 1997, the GASAT international meeting of 1999, and the IOSTE meeting of 1999.

During the second phase of the FEMSA project, the countries participating increased to a total of 12 and each country tried to implement strategies and interventions to address the problems identified according to their own priorities. In Uganda, a multi-faceted approach was taken to try and address the identified problems. The different strategies and activities to improve girls' participation in SMT therefore targeted the key stakeholders. These are, the teachers; the parents; the students both boys and the girls themselves; the general communities surrounding the schools; the policy makers and implementers; and the general public at large. In this paper one of the strategies targeted at the teachers as the key to the improvement of girls' participation and performance in SMT is discussed. This is the development of gender-inclusive instructional materials to complement and supplement the existing school curricula materials.

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### Why The Strategy Of Materials Development?

The problems identified by the FEMSA-Uganda research (Mulemwa 1997) included the gender-biased curricula including methods and instructional materials that "left the girls out" and the negative attitudes of teachers towards girls' education in SMT. Most teachers were not aware of the gender issues in education and in SMT education (SMTE) in particular and hence they unknowingly exacerbated the problems that girls experience in the learning of SMT. The strategy of school-based curriculum development was therefore implemented as a strategy to train teachers in the basic analysis and development of "girl-friendly" SMT content materials that can be used to supplementary the existing curricula materials. The strategy aimed at increasing girls' interest in and access to SMT through the use of relevant and gender-inclusive curricula content, and hence improving girls' active participation and performance in SMT at the school level.

### The Objectives Of The Strategy

The specific objectives of the strategy were to:

1. Develop materials that reflected examples from all the learners' experiences particularly those of girls;
2. Sensitize teachers on the need and importance of gender-sensitive and gender-inclusive curricula materials and methodology;
3. Train SMT teachers in the skills of materials development;
4. Demonstrate the process of School-based curricula development for possible mainstreaming;
5. Develop some gender-responsive materials for use in the classroom; and,
6. Build capacity in gender analysis and materials development, particularly for the women.

### The Process Of Materials' Development – An Overview

The process is quite long and includes the following major stages.

1. Training workshops to sensitize, train and acquire the necessary basic knowledge and skills in gender analysis;
2. Group and individual work to develop gender-inclusive and girl-friendly materials.
3. Workshops to review draft materials as they get produces, coupled with more training as necessary;
4. Re-casting the reviewed materials;
5. Reviewing of materials by other experts external to the core group;
6. Piloting the materials in schools;
7. Finalizing the materials to incorporate the feed back from the piloting exercise;
8. Producing the final materials;
9. Disseminating the final products to key stake holders;
10. Start on the activities for mainstreaming the materials.

### The School-Based Materials Development Activity

The materials development activity was implemented at 2 levels, namely, the national and the school levels. However, in this paper only the school-based level activities are discussed. There were 11 primary schools and 1 secondary school, all FEMSA-Uganda schools, which actively participated in this activity. The outline below mainly refers to the primary school level where the process seemed to work better. These primary schools had also been given Carpentry Kits by the project, in response to another identified problem of lack of school furniture. They had not only produced the furniture they needed, but also used the kits to produce some teaching/learning aid such as protractors, blackboard compasses, meter rules pulleys, clock-faces, calendars etc. These were incorporated into the materials' development activity. The activity had two specific phases, namely, the preparatory and the materials development phases.

**The Preparatory Phase**

The first phase of the strategy was the preparatory work, which basically included:

- Sensitization in gender issues and problems in education and SMT education in particular, and the introduction of the approach to the school authorities and the teachers through several seminars by the author who was also the coordinator of the overall programme;
- The development of guidelines for training of teachers and those for guiding the step-wise development of the materials, by the coordinator; and,
- Training of the SMT teachers in basic gender analysis techniques and skills in materials development. During the training workshops, the teachers were also given skills in setting quality test items and in some schools.

**The Development Phase**

This phase consisted of the following step-wise activities by the teachers:

- The identification of topics that are difficult to teach (learn);
- Developing materials in subject-specific or interdisciplinary groups depending on the materials to be produced. They were however often encouraged to work in mixed groups because of the need to acquire competency in both mathematics and science at the primary school level, and the need to integrate subjects;
- Organization of workshops for the teachers to work on the difficult topics with an experienced teacher, using a minds-on and hands-on approach as much as possible;
- More work by the teachers to finalize the topics discussed in the workshops and write them up as modules following and agreed format;
- The revision and correction of the draft materials by a more experience facilitator outside the school, but who is also an experienced primary teacher;
- Organization of follow-up workshops where the facilitator discusses the corrections and suggestions given, and offers more training as necessary;
- Revision of the materials according to the advice of the facilitator;
- The review of the drafts produced by another expert outside the whole process; and then the process continued as outlined above in the overview.

There were a few problems encountered the major one being the constraint of time and the lack of incentives for the teachers to do the work. Despite these problems however, the teachers greatly appreciate the activity because it clarified their own understanding of the subject matter, and they could immediately use the materials produced in their teaching. Consequently, they found time out of their very busy schedules and developed some modules. At the time of writing this paper, these materials were ready for step 5 of the process as indicated in the overview, namely, the external review by experts outside the development process, before they are piloted. The process did not find out concretely how the teachers used the draft materials in actual classroom situations as they developed them, and hence the instructional methods employed to teach the new content were not a focus at this stage. It was however realized that the gender sensitivity of the teachers seemed to have improved as they developed gender-inclusive content, which uses locally available materials as far as possible.

## The Proposed Improvements

Having initiated the FEMSA project in Uganda in 1995 and working as the National Coordinator of the FEMSA-Uganda project for over 4 years, the author stopped working directly with the project in May 2001. However, given the personal interest in girls' education, particularly in SMTE, the author has taken time to reflect on the FEMSA-Uganda activities, and specifically the school-based curricula development activities as discussed above. In the remaining part of this paper, proposals to improve this process are discussed. It is believed that if implemented, the proposals would greatly enhance the effectiveness of the school-based curriculum development process in increasing all learners' participation in SMT, particularly the girls, and hence improve their performance even more. The proposals focus on 3 areas, namely, the involvement of the pupils, particularly the girls in the process of curriculum development; emphasizing and developing the "reflective

process" of the teachers; and the active involvement of the school authorities and the parents and the surrounding community in the process.

**The Active Involvement Of The Pupils**

The pupils can be involved in the whole process of curriculum development at the school level. If this involvement is planned and hence deliberately and systematically implemented, the girls in particular would be given a relatively new experience which should arouse their curiosity and interest, allow them active practical experience of SMT outside the classroom, and hopefully improve their performance in SMT. The involvement of the pupils can be at three different levels as discussed below.

**1. Identification of the Difficult Topics**

As outlined above, the process of school-based curriculum development starts with the identification of the topics that are difficult to teach, by the teacher, with the reasons why this is so. The proposal here is that, the pupils too, should carry out a similar exercise. The FEMSA project in Uganda however found out that the pupils particularly at the primary school level could hardly articulate the reasons why particular topics were very difficult (Mulemwa 1997). They therefore need assistance and step-wise guidance at first, to learn and feel confidence in pinpointing what they do not know and diagnosing the reasons for their lack of understanding. It should be noted here that in a different research study (Mulemwa 1995) the teachers too, found a similar exercise difficult, although the underlying reasons were quite different. They too had to be assisted to gain confidence in admitting what they did not know and then they comfortably continued the process.

In identifying the difficult topics and the reasons for the difficulties experienced, the pupils should be assisted by someone they can trust. In my experience, this should not be their teacher or a member of the school administration, because then they may either be intimidated into silence and/or fear repercussions. This is because quite often the reasons involve poor teaching methods by the teachers, and rushing through content with hardly any time to reflect and ask questions, let alone practical work to facilitate learning. However, with time and if both the teachers and the pupils are comfortable, then they can work on this identification together. This would be the most ideal situation, but the teachers would have to drastically change their "know it all attitude" and develop confidence in the pupils to raise their learning problems without being penalized as being critical of or rude to the teachers.

The role of the facilitator in this process is therefore to train the learners in taking responsibility for their own learning, by analyzing their own learning styles and problems and articulating these issues as clearly as possible. The different ways of identifying the difficult topics or areas, and the reasons why, include the use of questionnaires, discussion groups and diagnostic tests by the teachers. Given that most people fear to expose their ignorance, the questionnaire would be the best method. Unfortunately, many pupils do not articulate well enough on their own for the data collected to be very useful (Mulemwa, 1997). On the other hand, very few have the guts to admit "ignorance" in a group. Therefore it is better to use a combination of all methods. This can be augmented by tests, which are specifically constructed to diagnose the learning difficulties of pupils and problematic content areas. Such a multi-pronged approach should yield useful result in terms of not only the difficult topics, but also more importantly, a comprehensive list of reasons for the difficulties experienced.

**2. The Drafting Stage**

Having identified and prioritized the difficult topics, the teachers start on the development of complementary and supplementary gender-inclusive materials, identifying teaching/learning aids and materials that could be utilized with the new content. The pupils too, can be actively involved at this stage. In fact the students are in a good position to contribute to the gender aspects of materials development by sharing their experiences, interests and fears with the teachers. The can pupils' participation in several ways. After identifying possible specimen, the teacher can get the pupils to collect some things like used bottles, pieces of wood for improvisation, insects, seeds, leaves and the like, from their environment, and in the process learn more about them. They can draw diagrams of some of the specimens for possible use in the classroom. Such diagrams

include those showing the different parts of the body, of seeds or leaves and the like. The learners will automatically learn some SMT facts; make useful observations as they draw the specimens; and this would form the basis for questions, problems and issues for appropriate discussions in class. With some guidance and appropriate instructions from the teachers, pupils can further design and/or construct or make some teaching/learning aids, such as a First Aid carrier "bed" in science, models of different shapes in mathematics, models of pulleys and carts for S&T, as well as charts and diagrams of different processes and things as indicated above.

**3. Piloting the Draft Curricula Materials**

The supplementary and complementary curriculum content and teaching/learning aids developed have to be piloted to find out their effectiveness in an actual classroom-teaching environment. This process would be made a lot easier, more interesting and hence more beneficial to the learners, if they were actively involved in the development of these materials as outlined above. The teachers can then critically but constructively use the work of the pupils to discuss the content. This in itself would be very motivating to the pupils, and particularly so if the best diagrams or other aids constructed, or write up of a process, could be rewarded. The reward does not have to cost anything, as it can take the form of judicious praise in class, pinning the winning chart or diagram on the notice board or a having good piece of work displayed in the classroom or school. The pupils are then likely to be more eager to participate in the next set of curriculum development activities after a positive experience as outlined above.

## Developing The Reflective Process Of The Teachers

A good teaching process should be spiral in nature, where by the teacher prepares for a lesson, teaches it, and then reflects on it consciously to learn from both the positive and negative aspects of it, so that the next lesson can be better. Unfortunately, the teachers in many African classrooms are so overwhelmed by the prevailing circumstances that they hardly have time to consciously reflect properly on what they are doing and why they are doing it. This can be attributed to several causes. First, the poor salaries and other conditions of service mean that the teachers have to supplement their incomes through other work and hence have little time to prepare professionally for lessons. Therefore, any additional activity such as working with pupils on the development of teaching/learning aids, which presents a lot of extra work, is understandably avoided. Secondly, the teacher's work is also made more difficult by the large class sizes, coupled with poor resources. Lastly, the most common method of teaching is the Lecture type method (Ebout Mfou et al, 1998). The teachers therefore lack the experience and confidence to use more creative methods like the project or fieldwork in the classrooms, and yet these are methods that would enable a teacher to reflect more purposefully as they prepare to teach using them. What is being proposed here is the emphasis of a deliberate reflective process on the part of the teachers as they prepare curricula materials in the process discussed earlier. While this process occurs even subconsciously to some extent as one develops the materials, it needs to be emphasized at three distinct stages, namely, at the stage of identifying the difficult topics, the development of the draft materials with the learners, and as the materials get piloted in the classroom.

**1. Identifying the Difficult Topics**

A research study carried out in Uganda (Mulemwa 1995) showed that secondary school teachers generally find it very difficult to admit what they do not know with regards to what they are supposed to teach at the school level. This is not only because of the fear of being labeled as ignorant, but it is probably also due to a more deeply embedded and hence unconscious expectation and attitude that "the teacher knows or must know it all". In this research, the objective was to identify what the teachers found difficult to teach. However, all of them always started by identifying what "the students found difficult to understand" and squarely put the blame for the lack of understanding on the students. Moreover, the teachers were not easily forthcoming in pinpointing the exact source of the problem once the topics had been identified. It was only through deliberately guided small group discussions that teachers slowly admitted to finding difficulties in teaching

some topics. During such discussions, some teachers confused concepts as well, thus unknowingly, but clearly showing their lack of understanding of these concepts, such as a "mole" being used synonymously as a "molecule" in chemistry. When they eventually admitted to some lack of confidence in teaching any topic, the major reason given was often the lack of textbooks and materials for use with the topic. They did not easily admit that their lack of understanding of the concepts and theories involved in most of the identified topics could be making the identification of appropriate teaching/learning aids very difficult let alone those for improvisation.

We had similar experiences at first, in the FEMSA –Uganda project with primary level teachers as we tried to identify difficult topics for addressing in the school-based curricula development activity. This is why the proposal for a more deep and reflective process at this level is being advanced here. An effective reflective process would require a detailed analysis of what the study of each topic calls for. This is first of all in terms of the key theories, concepts and principles that one needs to know and to build on in order to facilitate the understand of the new topic, as well as those that should be taught as part of the topic. Such a detailed analysis helps to pinpoint the area of difficulty and hence the identification of appropriate illustrative examples, methods and aids that can help to teach the content more effectively. The reflective process on the part of the teacher is deepened and becomes even more useful if the teacher also work with the students, guiding them in their own analysis of the problem areas as already indicated above. In this process, the teacher would further clarify the difficult areas, concepts and principles.

The difficult topics identified by the teachers are likely to be very similar to those identified by the students because students can hardly be expected to understand topics that the teachers themselves find difficult to teach. It is such topics that should be addressed first in developing curricula materials.

**2. Developing the Draft Materials**

Developing materials is a long and time-consuming activity, and the proposed reflective process would make it even longer. However, the products should be much more suitable to the learners in facilitating their understanding, and in the long run, both the teachers and the students would find the teaching/learning process easier. At this stage, the teachers need to focus on the reasons identified as making the topic difficult both from the point of view of the teachers, and from that of the students. The reflection is deepened if the teachers engage the students in the collection and preparation of some teaching/learning aids. As indicated earlier, the teachers need to guide the students on what is likely to be needed and hence collected and/or made. Examples of this include the close observation of the life cycles such as those of a tadpole, or butterfly from egg to the adult species; seed dispersal, germination or flower pollination; making models of farm implements like wheelbarrows and rakes, or pulleys; collecting data such as age, height or population aspects and presenting it in the form of graphs and pie charts. The teacher has to develop some guidelines for the students to follow as they collect and prepare possible specimens and/or make other aids. This would effectively constitute assignments to the students such that by the time the topic gets discussed in class, the students would have had some experience with it and it would be more familiar to them. The teacher can for example ask the pupils to write up how and where they got or found each of the specimens they collect; design a flow chart or diagrammatically represent local process such as the making of bread or local beverages. Students will then have to do some research and hence acquire basic research skills and knew knowledge.

It is important to note here that the process as discussed above of necessity employs the more creative methods like the project method, discussion and fieldwork. Both the teachers and the students would therefore be experiencing and training in the skills of "learning how to learn". These skills are vital in the world today because as Costa and Liebmann (1997, p. xxii) stated, *"—knowledge doubles in less than 5 years and is projected to double every 73 days by the year 2020"*. They continue to say that, *"it is no longer feasible to anticipate the future information requirements of individuals. We must look differently, and with greater depths, at what learning is of most worth"*. They further went on to say that, *"we need to nurture skills, operations and dispositions that will enable individuals to solve problems when answers are not readily known. Educators need to embark on*

*radical reforms that shift away from content to process and to value the collective intelligence of the group, as well as the intelligence of each learner".* This quotation captures the essence of the need to train learners in the skills of "learning how to learn", and the reflective process above on the part of the teacher can be used to inculcate such skills in a non-threatening atmosphere, as students would be carrying out the work outside a classroom situation. The students would further have to work together, consulting and cooperating with others, and hence learn to value collective knowledge. This would predispose them to "cooperative learning" in the classroom. This is an approach that is almost totally absent in the African classrooms, and yet it offers an appropriate alternative learning style, particularly for the African girl child. As Okebukola (1996, p. 33) put it, *"Cooperative learning is predisposing to the African socio-cultural orientation, facilities limitation and acquisition of knowledge, skills and attitudes in science and technology".* Moreover, it also emphasized the importance and *"value of the collective intelligence of a group"* as pointed out by Costa and Liebmann (1997p. xxii), which is very desirable today.

As the students discuss the progress of their assignments, the reflective teacher should be able to identify "alternative conceptions" and/or "mis-conceptions" of the students, and perhaps their own too. When these are known, then the lessons can be prepared in such a way that the mis-conceptions are challenged, hence assisting the students to re-construct their knowledge in a more scientifically acceptable way.

**3. Piloting the Materials**

The curricula content and all materials developed have to be tried out in a classroom situation to validate their effectiveness. The lessons should be livelier, if the students too, participated in the development of some materials as discussed above. In continuing with the reflective process, the teacher should endeavour to use the students' materials as much as possible and help the students to critically examine and discuss those selected as the most appropriate for use in the lessons. If properly used and with constructive criticism, even those students whose materials are not so good would be motivated to improve on them, while those whose materials are good could be encouraged to help others so that they too could improve even more in the process. The use of students' materials in the classroom is a very good motivator for them. The good materials like drawings, diagrams, write-ups, specimens or constructed materials could be appropriately displayed and/or exhibited. The students would then be even more motivated and willing to engage in the development of more materials.

As indicated above, the use of method such as fieldwork, the project, discussion, and individualized assignment for carrying would be inevitable. These are methods that facilitate the acquisition and development of the higher-level abilities of analysis, synthesis and evaluation. They further involve personal initiative and creativity. Consequently, the psychomotor skills and attitudes towards SMT are likely to improve in addition to the higher cognitive abilities, and hence participation and performance in SMT. The methods also involve collective responsibility and are bound to impact profoundly on the individual learners, helping them to clarify their personal interest or dislike of SMT subjects. Whatever the personal interest turns out to be however, the learners would have learnt the skills of "cooperative learning" and working together to achieve a common goal, and the skills and attitudes necessary in "learning how to learn".

As the materials get piloted, both the teachers and the students would identify more "fuzzy" areas and the process of refining and developing more materials would continue. Once the teachers and the students gain the confidence of admitting that they don't know, the analytical skills of identifying what they don't understand, and the skills and attitude of trying to devise means and ways of alleviating the problem and hence research, then the process of "learning how to learn" would have been institutionalized. It should be underscored here that the methods above, which employ the cooperative learning style might be more attractive and hence effective to the girl child than the individualistic and competitive lecture method learning style.

## Involving The School Authorities And The Community

The process of school-based curriculum development, which actively involves the pupils and the teachers as discussed above cannot be successful without the support of both the school authorities and the community. This support, especially that of the parents of the school and the general surrounding community is vital if the process is to be sustainable.

### The Role of the School Authorities

The school authorities can offer support to the school-based curriculum development process in several ways. First and foremost, the teachers need to be sensitized to the problem of gender biases in education and SMT in particular, and trained in gender analysis and materials development. This must be planned such that regular workshops and seminars are organized for the teachers, employing appropriate facilitators, as opposed to a once-in-a-while workshop. The school authorities need to recognize the great shift in mind-sets that is required by this approach and therefore be prepared to offer supportive training to the teachers for quite some time. The FEMSA-Uganda experience showed teachers get greatly encouraged when the school authorities also participate in some of the training and/or the materials development activities. This is quite beneficial to the authorities too, not only because they equally need such training, but also because they can forge a closer working relationship with the teachers through these activities. They further get equipped with the knowledge and understanding of the issues and what needs to be done, and are therefore likely to be more effective in mobilizing support for the process and for the school.

It is vital that the school authorities allow the teachers time to engage in the activity without encroaching too much on the teachers' free time. For example, a lot o work can be done within the normal school working days without the learners loosing out, instead of taking up all the weekends. However, this requires proper planning and timetabling on the part of the school administration. The school authorities should provide the necessary stationery and other materials needed for the activities, while encouraging improvisation and the use of locally available materials as much as possible. They should further organize regular sensitization meetings and workshops for the parents and general community, on the need and value of education, particularly for the girl child in SMT. The community needs to be educated on the goals of a good education, highlighting the importance of the strategy of school-based curriculum development as crucial in achieving such goals. This sensitization is necessary in order to ease the mobilization of resources and general support for the process. Last but very important, the school authorities should endeavour to provide some incentive for the teachers, in terms of refreshments or meals as necessary, or even a small allowance where possible.

### The Role of the Parents and the Community

A well-sensitized community can offer a lot of support the school in general and the curriculum development process in particular. First, the parents have to allow their children particularly the daughters, time to participate in the curriculum development activities at the school, especially if they take place after the usual school hours and/or on weekends. They also have to give them time at home for these activities. They could assist, guide and facilitate them in the school assignments that have to be done at home, such as project work, depending on their own potentials. The community, particularly the parents can even directly participate in the process of curriculum development through the practical assistance they give to the learners. As noted by Mulemwa (2001) they *"can help in the provision of SMT teaching/learning aids such as specimens, local materials like bottles, tins, and wood for improvisation, and their own home facilities like carpentry and metal workshops, gardens and farms for demonstrations and even practice and application of school SMT concepts and ideas. Furthermore, appropriately qualified and/or experienced members of the community can be oriented to assist teachers in either teaching or demonstrating particular skills and imparting values".* Otherwise, the parents and the community also provide a safe and encouraging environment particularly for the girl child, to explore and develop interest and skills in SMT. They can further contribute resources to facilitate the process and offer incentives to the teachers and the learners, thus complementing the efforts of the school authorities.

**Concluding Discussion**

During the period of 1992-1994, the author was exposed to, and participated a little in the work of teacher educators in Alberta, Canada through the University of Alberta, department of Science Education, on their efforts in "teaching thinking" (Alberta Education 1990 a) and "research" (Alberta Education, 1990 b) to learners. These educators had developed science material and models designed to help students grow in their abilities to gather, process and share information, a process that requires critical thinking skills. They had further developed materials to teach thinking skills and to develop students' research skills, at school levels. While the process called for a lot of hard work, initiative and creativity on the part of the teacher because it involved hands-on and minds-on work, the students enjoyed it very much and participated very actively. This experience spurred the author to carry out a research study with her own classes on "helping learners to take more responsibility for their own learning", in 1995-1996. The learners were post-graduate Diploma in Education Chemistry Methods students at Makerere University. The gist of this study was that students had to critically examine each lecture given, in terms of the appropriatenes[illegible]f effectiveness of the instructional methods and aids employed by the lecturer in facilitating their own learning of the content of the lecture. In doing so, they had also to identify any other barriers to their learning and suggest improvements.

The unpublished research work (Mulemwa 1996) clearly revealed and demonstrated several findings that are very informative for the teaching/learning process. First, the learners did not want to carry out the extra work of critically reflecting on the teaching/learning process, since it was not to contribute towards their examinations. The researcher, as a lecturer had to insist on having it done and had the reflections of the students discussed seriously before each new lecture. Secondly, the students found difficulties in identifying and in diagnosing their own learning so as to identify any problems. Thirdly but very critical, the students feared victimization by the lecturer (who was also the researcher) if they gave reasons that directly or indirectly reflected on her negatively, such as poor preparation and instructional methods. In fact, the lecturer/researcher had to design exercises where the students' critical reflection could not but yield negative criticism, if they were honest, so as to develop their confidence in giving constructive criticism. Fourthly, the research demonstrated that having gained confidence in identifying the problems and the causes, constructive criticism was not easy, because one had to suggest a way forward in terms of better alternatives or ideas. Lastly, but most important, the overall finding was that, towards the end of the one-year course, the students had gained the skills and confidence and were beginning to even suggest ideas of what could be done, as the lecture proceeded, rather than waiting to do so at the end. For example, during one double lecture, students requested that the lecturer changes the topic or method because they had had a big party the night before and most of them were finding it difficult to keep awake. This request clearly demonstrated the confidence the students had eventually acquired in sharing their learning problems with the lecturer/researcher. Their request was of course granted, but after a brief discussion of the implications of both their own discipline in social matters and the suggestions of how else the rest of the lecture could be conducted to their benefit. The unfortunate thing was that, having taken almost a year to inculcate the self-confidence and skills for self-reflection and critical analysis of ones learning process, there was no time with these students to proceed to the next stage, which is where the whole process was aimed at. This was for the Lecturer/researcher to capitalize on their newfound confidence and employ methods that called more on their own initiative and creativity.

This research however gave clear indications that it is possible to achieve the objective of empowering learners to take responsibility and hence active participation in their own learning. Consequently, it should be relatively easier to achieve such an objective at school level because of two reasons. First, one has a lot more time to work with the learner and develop the necessary confidence and skills till they are well assimilated. Secondly and even more important, the learners are still young and quite flexible at that level and can hence be easily trained and influenced into any desirable way of thinking. In concluding this paper therefore, let me summarize the advantages of the school-based curriculum development process proposed above as a way of highlighting its importance and effectiveness in encouraging and improving the access, participation and performance of the girls in particular, in SMT at the school level and beyond. The advantages are as follows:

1. The approach encourages the active participation of the learners in seeking knowledge and exposes the learners to specific SMT processes and experiences, which help them to develop interest in SMT. This is particularly important for the girl child who is otherwise often denied such explorative and investigative experiences because of the cultural norms. The parents are more willing to allow such experience for the girls when it is part of the learning process at school.
2. The process potentially allows the learner to actively and extensively interact and get support from the two most important categories of people who also impact profoundly on any learner (Mulemwa 2001), namely, the parents and the teachers.
3. The learner is developed holistically, in terms of all the cognitive abilities, the psychomotor skills and the affective domain or attitudes.
4. The approach develops not only the science skills, but also the process skills, since the processes are emphasized as one reflects on what needs to be done and how. The major advantage here is the development of the skills of "learning how to learn" which are vital in the rapidly changing world.
5. The approach employs a cooperative learning style, with collaboration and consultations among and between the teachers and their students. It therefore inculcates the need to complement each other's efforts, the importance of group knowledge and collective responsibility, among teachers and students. This learning style reflects the more traditional learning approach in many African cultures. It may therefore greatly improve on the acquisition of the desire knowledge, attitudes and skills, particularly by the girl child because it presents an approach to learning that is quite familiar to her, given her social-cultural training. It also offers an alternative learning style.
6. The approach assists learner and teachers alike to develop interest in SMT as well as problem solving skills, which is an important and desirable utilitarian outcome of SMT education.
7. If the training is done effectively, then some teachers would emerge from the school as leaders, who can be trained as trainers so as to sustain the process with minimal costs. The approach therefore presents an effective mode of curriculum development, which is also very cost-effective in terms of sustainability. This is a very crucial aspect in Africa where the need for revising the curricula is great, yet the resources are very limited.
8. Equally important is the fact that the products of the process are immediately utilized at the school level, where they are targeted, rather than take years to get there, as in the usual centralized approach to curriculum development.
9. As the teachers carry out the materials development activity using the process outlined above, they not only design gender-inclusive content, which uses locally available materials as far as possible, but also inevitably employ gender-inclusive instructional methods. Consequently, they practice the use of the methods and appreciate the power of these methods in increasing interest and understanding in the learning of SMT.
10. The approach tends to close the widening gap between the educated and the communities.

The approach as presented requires a lot of sensitization and commitment of the school authorities and teachers. It requires a lot of time and initiative as well as strategic and systematic planning and collaboration between the teachers, the school authorities and the community, especially the parents. It further requires a coordinator who believes in the effectiveness of the approach so that they can have the patience and intrinsic motivation to facilitate its implementation to a successful conclusion. The coordinator must have the capacity and ability to direct the course of this process, monitor and offer supportive supervision to the teachers, as well as be a good advocate for the process and its products so as to ensure their mainstreaming at the appropriate time. Otherwise, the long-term sustainability of the approach greatly depends on the active involvement and support of the school authorities and the communities.

In Africa, the collaboration of schools with their surrounding communities is becoming very important because these communities are increasingly being called upon to support and complement the efforts of governments in the provision of education, particularly basic education. For example, at the Commonwealth Countries Expert Group meeting of 1998 (Commonwealth. Secretariat, 1998, p. 15), it was found that 6 of the 12 countries that were represented had definite and direct parental involvement in schools through contribution of resources. Therefore, the systematic and regular sensitisation of the communities about the importance of

education in SMTE is vital. When a good relationship exists between the school and community, then the school prospers academically and otherwise. This involvement takes the form of participation in school programmes; being role models or instructors; encouraging, supporting and enforcing discipline at school, at home and in the community; and contributing resources to improve the social welfare and academic performance of students, teachers and the school in general. Even more specifically, the parents and other members of the community can participate in the process of school-based curriculum development and implementation through the provision of teaching/learning materials and facilities like their gardens and workshops for teaching and demonstration purposes. As Mulemwa (2001) pointed out, *"The involvement of communities in school curricula in this particular way is extremely desirable in Africa because it brings out the vital message of the immediate utility of the school SMT curricula content being taught, and stops the alienation of the school, and most importantly of the learners, from the community"*. The learners, particularly the girl child would then be assisted to access, enjoy and participate more actively in the learning of SMT. They would then persist and work hard to achieve good performance and in particular, more girls would be able to pursue SMT studies to higher levels, and hence increase their numbers in the SMT-based jobs and careers.

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**Key Words:** Materials' development; gender sensitivity and gender-inclusive; active participation; reflective teacher; difficult topics; instructional methods; cooperative learning; teaching/learning process; teaching/learning aids; cognitive abilities; psychomotor skills; attitudes; teachers; students; school authorities; parents; community;

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